Nymphalid butterfly communities in an amazonian forest fragment

Frederico Araujo Ramos

Departamento de Biociências, Centro Universitário de Brasília, SEPN 707/907, 70.790-07, Brasília, Brazil, E-mail: *framos@tba.com.br*

Abstract. Species diversity and abundance of fruit-feeding nymphalid butterflies were studied in an Amazon rain forest fragment. Butterflies were caught in baited traps in twelve areas, selected to sample a gradient of increasing disturbance. Measurements of six parameters of vegetation structure were also taken to estimate the disturbance. A total of 90 butterfly species were trapped. The greatest alpha diversities were found at the edge of the forest and in areas of intermediate disturbance. Canonical Correlation Analysis (CCA) showed that the composition of the species assemblages of nymphalids was related to vegetation structure variables, especially girth at breast height and number of tree morpho-species. The butterfly fauna appeared more similar in forested areas than in the disturbed ones. Some species were suggested as habitat indicators and the value of this guild of fruit-feeding butterflies in conservation programs is discussed.

Key Words: Butterflies, nymphalids, diversity, community structure, disturbance, rain forest fragment, direct gradient analysis, Brazil.

Introduction

One of the main objectives of community ecology is the synthesis of the roles of physical and biological factors that determine species abundance and distribution within and among natural communities. After MacArthur and MacArthur (1961) found a relationship between bird diversity and high vegetation diversity, ecologists verified that habitat complexity is an important factor for the structuring of local communities. Habitats that are structurally more complex and heterogeneous offer more niches, and therefore support a greater number of species (spatial heterogeneity, Pianka 1966). In addition this idea, Connell (1978) suggested that high diversity in tropical forests is maintained by disturbances, such as tree falls. Considering such dynamics, the forest can be seen as a mosaic of gaps in different successional stages, with different local communities, and a high regional diversity.

Although biogeographic and historical conditions are extremely important factors in structuring communities (Slansky 1972, Ricklefs 1987, Leps and Spitzer 1990, Brown 1982, Brown 1991, Thomas 1991, Gaston 1996), local factors also affect local butterfly diversity (Emmel and Leck 1969, Montesinos 1985, DeVries 1994, Kitahara and Fujii 1994, Sparks and Par-

ish 1995). Many studies have shown that tropical butterfly communities also respond to physical factors of the habitat, such as topography, stratification, gaps, edges, urbanization and habitat disturbances (Ruszczyk 1986, DeVries 1988, Raguso and Llorente-Bousquets 1990, Brown 1991, Hill et al. 1992, Pinheiro and Ortiz, 1992, Hill et al. 1995, Spitzer et al. 1997). As such, multivariate analysis has proven to be an important tool when investigating the relationships between species assemblages and environmental variables (Leps and Sptizer 1990, Kremen 1992, Ramos 1992, Väisänen 1992, Spitzer et al. 1993, Spitzer et al. 1997, Blair and Launer 1997).

The objectives of this study are (1) to measure neotropical nymphalid butterfly diversity along a gradient of disturbance, (2) to explore the species-environment relationships through a direct gradient analysis and (3) identify the most important butterfly species and vegetation variables, which could be used in conservation monitoring programs.

METHODS

Study site. This study was conducted in a forest fragment at the boundary of the eastern Amazon (5°01´S, 47°32´W; 260 m), a region where the natural landscape has been greatly modified by human activity. The study site was about 50 km north of the transition to Cerrado. The fragment has about 1,000 ha of primary forest with several levels of disturbance, surrounded by secondary forest in several succesional stages, eucalyptus monocultures and cattle pasture. I selected 12 sample units (SUs) throughout a disturbance gradient: forest understory (FU1, FU2, FU3), forest roads (FR1, FR2, FR3), edge (EDG), highly disturbed forest understory (DFU), highly disturbed forest road (DFR), 4-year-old secondary forest (SF4), 2-year-old secondary forests (SF2) and *Eucalyptus pellita* monoculture (EUC).

Data collection. I made lepidoptera collections between June 1990 and July 1991. For each of 12 SUs, three fruit-baited traps were set in line, suspended 1.0-1.7 meters above the ground, and 25 meters apart from one another. For each collection, the traps were visited for 14 consecutive days. The banana and sugar cane bait was kept moist for the duration of the trapping period. The disturbance level of each SU was estimated using vegetation parameters obtained through the point-centered method (Müller-Dumbois and Ellemberg 1974), with 21 quartered points established per SU, only for trees up to 20 cm of circumference at breast high. This method was chosen for its simplicity and common use in phytosociological surveys. The following vegetation variables were used: average g*irth at breast hight* (GBH); estimated average *tree height* (THG); n*umber of tree morpho-species* (NMS) estimated by rind and leaf characteristics, with the help of a local guide; *tree density* within 100 m² (DEN); average *horizontal cover* (HOC), estimated at each sample point by an observation made on a 50 cm square carton held 10 m from the observer in each quarter. Cover was estimated to be within one of four categories (0-25%, 25-50%, 50-75% and 75-100% vegetation cover); average *vertical cover* (VEC), estimated by the four previously mentioned vegetation cover categories, apllying a 10 cm square frame held at a distance of 60 cm from the observer at an angle of approximately 20° in relation to zenith.

Table 1. Alpha diversity of fruit-feeding butterfly species in twelve sample units of an Amazonian forest fragment.

	Forest understory			Forest road			Edge	Disturbed forest		Secondary forest		Eucalyp monoc	
	FU1	FU2	FU3	FR1	FR2	FR3	EDG	DFU	DFR	SF4	SF2	EUC	Total
Number of individuals (N)	63	43	97	114	111	106	334	267	571	490	744	604	3544
Nymphalinae richness	3	5	6	11	13	12	15	16	19	17	16	12	29
Satyrinae richness	13	11	15	14	16	13	27	14	20	19	20	17	41
Brassolinae richness	1	1	2	0	1	1	5	2	4	3	2	2	6
Charaxinae richness	0	2	3	2	3	6	6	6	6	7	3	3	13
Total species richness (S)	18	20	27	28	34	33	54	39	50	47	42	34	90
Species diversity (H´)	2.27	2.76	2.60	2.79	3.08	3.06	3.38	3.06	3.19	3.00	2.28	2.09	3.26

Data analysis. The butterfly alpha diversity of each SU was quantified by the species richness (S) and Shannon-Wiener index (H'). To evaluate environmental effects on the butterfly community I ran a Canonical Correspondence Analysis (CCA), using the program CANOCO (TerBraak 1988). The vegetation parameter estimates of habitat disturbance were used as environmental variables in the CCA. The variable tree height was removed from the analysis due to its high value of inflation, and high colinearity with the other variables. The significance of species-environment relationships was tested using a Monte Carlo test.

RESULTS

A total sample effort of 2,016 trap days (=3 traps x 12 SUs x 56 days) resulted in 3,544 individuals collected, representing 90 species of five subfamilies of Nymphalidae. The five most abundant species were *Paryphthimoides phronius, Yphthimoides* sp1, *Yphthimoides disaffecta, Hermeuptychia hermes* and *Cissia penelope,* all belonging to the subfamily Satyrinae, representing 45.3% of the total number of individuals collected. A complete list of species abundances in each SU can be seen in Appendix 1. The total butterfly diversity in the rain forest fragment sampled was H´ = 3.258.

An analysis of alpha diversity showed that edges and areas of intermediate disturbance presented higher species richness and diversity (Table 1). Although more disturbed areas, such as eucalyptus monoculture and 2-year-old secondary forest had higher species richnesses than forest, they had lower species diversities, due to the high dominance of the Satyrinae species. This pattern was not found when other groups were considered separately: Satyrinae and Brassolinae had higher species richnesses in the disturbed areas, with a peak of the edge; Charaxinae and Nymphalinae had higher species richnesses in the road, edge and disturbed forest areas.

The CCA ordination diagram shows the relationships between butterfly species, sample units and environmental variables (Figure 1). By comparing the arrow lengths, one may evaluate the significance of the constraining vegetation variables. The arrow points roughly in the direction of the maximum variation in the value of the corresponding variable. The spe-
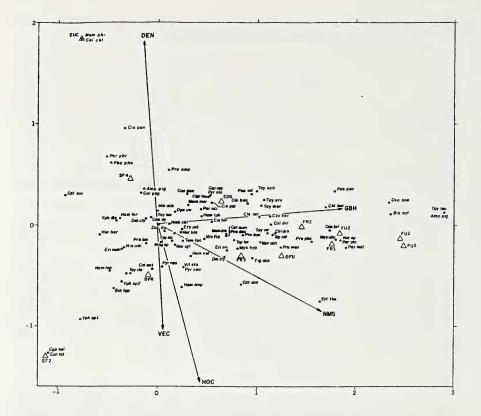
Figure 1. CCA ordination of the fruit-feeding butterfly communities in an Amazonian forest fragment, with respect to five vegetation variables (arrows). The species are abreviated according to the first three letters of their generic and the first three letters of their specific names (see Appendix 1 for full names). The vegetation variables are: average girth at breast height (GBH), estimated average tree height (THG), number of tree morpho-species (NMS), tree density within 100 m² (DEN), estimated average horizontal cover (HOC) and estimated average vertical cover (VEC). The sample units are forest understory (FU1, FU2, FU3), forest roads (FR1, FR2, FR3), edge (EDG), highly disturbed forest understory (DFU), highly disturbed forest road (DFR), 4-year-old secondary forest (SF4), 2-year-old secondary forests (SF2) and *Eucalyptus pellita* monoculture (EUC).

cies far from the origin are rare and less important to analysis. The Monte Carlo permutation test showed that those species are significantly related to supplied vegetation variables (99 permutations, P < 0.01).

In the first CCA axis, girth at breast height presented the highest absolute value, followed by the number of tree morpho-species, both contributing to the species data fit. This axis clearly shows a gradient of disturbance — preserved areas with a greater richness of large bole trees on the positive side, and disturbed or early succesional ones on the negative side. The

ordination also shows how species respond to vegetation variables: with in-
vader species typical of open areas (the small Satyrinae *Hermeuptychia
hermes, Yphthimoides sp1, Y. disaffecta, Cissia penelope, Erichtodes numeria* and
Pharneuptychia pharnaces, and the Nymphalinae *Hamadryas feronia, H.
februa* and *Biblis hyperia*) showing negative scores. With positive scores,
near the origin, are the heliophyllous species of the disturbed forests, gaps,
edges and canopy (*Eryphanis polyxena, Hamadryas iphthime, H. velutina, Mem-
phis morvus, Narope cyllabarus, Nica flavilla, Pareuptychia ocirrhoe, Temenis laothoe*
and *Taygetes laches*). The species on the right side of the diagram are typical
of the forest understory (*Colobura dirce, Morpho achiles, Nessaea obrinus, Taygetis
celia, T. echo* and *T. virgilia*). The second axis was primarily related to tree
density and horizontal cover, but did not form a clear gradient. The analy-
sis gave a large weight to some Satyrinae species, such as *Cissia penelope* and
Paryphthimoides phronius, which had large populations in high tree density
eucalyptus monoculture.

Discussion

The forest edge and intermediate disturbance forest presented higher
values of butterfly species richness and diversity. These environments, where
intense regeneration occurs, have high productivity and maintain high
population levels. On the other hand, the disturbance rate is high, thus
reducing the effect of competitive exclusion. A number of ecologically based
hypotheses have been proposed to explain patterns of species richness and
diversity, but not all of them are mutually exclusive (Meffe and Carroll 1997).
The productivity-disturbance hypothesis (Huston 1994) combines elements
of several other hypotheses, proposing that the high productivity and the
disturbance rate conditions of forest edges and gaps result in high species
richness. The results of this study tend to agree with this hypothesis. Addi-
tionally, the mixture of forest understory umbrophyllous species with open
area heliophyllous ones raises the local diversity. The fact that edges, gaps,
physiognomic transitions, and disturbed and secondary forests have high
diversity has been documented many times elsewhere (Leps and Spitzer
1990, Raguso and Llorente-Bousquets 1990, Hill et al. 1992, Pinheiro and
Ortiz 1992, Väinsänen 1992, Spitzer et al. 1993, Spitzer et al. 1997). For
sunloving species, drastic changes in light intensity can act as a habitat bar-
rier, while edges, gaps and canopies may be treated as a continuum of sunny,
open area. Other species, however, remain restricted to shady environments
(DeVries 1988).

The number of tree morpho-species was not a good predictor of the num-
ber of butterfly species. Because the group is herbivorous, butterfly - host
plant relationships have been explored (Gilbert and Smiley 1978, Erhardt
and Thomas 1991), although not always being meaningful (Sharp et al. 1974,
Courtney and Chew 1987, Singer and Ehrlich 1991). Besides that, the sam-
pling considered only trees, and did not consider bushes, herbs and lianas
that are host plants of several butterflies (DeVries 1987). Although not re-
lated with butterfly alpha diversity, the number of tree morpho-species was

important in the formation of an environmental gradient, and is related to habitat disturbance.

The ordination diagram shows that the forest assemblages are homogeneous, but among disturbed areas there are great variations in species composition and abundance. A larger constancy of forest communities has been verified for neotropical satyrins (Brown 1991), and butterflies of South-eastern Asia (Leps and Spitzer 1990), but the opposite pattern was found for Notodontidae and Arctiinae in the same forest fragment (Dubois 1993).

Although other butterfly groups such as Ithominae and Heliconinae have been suggested as more efficient indicators (Brown 1991, Beccaloni and Gaston 1995), the use of the fruit-feeding Nymphalidae has its utility in conservation programs (Daily and Ehrlich 1995). The results of the CCA ordination show that butterfly communities have a significant relationship with vegetation variables, and suggest the use of this assemblage as an appropriate indicator of habitat heterogeneity over this spatial scale. CCA can be used to match a species assemblage to environmental factors for which it is a good indicator, and select a subset of species as indicators for more intensive monitoring (Kremen 1992). Since rare species have little weight in the analysis (TerBraak 1988), common species, and not rare ones, should be selected from this guild to be used as indicators. Thus, *Hermeuptychia hermes, Yphthimoides sp1, Y. disaffecta, Cissia penelope, Erichthodes numeria, Pharneuptychia pharnaces, Hamadryas feronia, H. februa* and *Biblis hyperia* may serve as indicators of disturbed environments, and *Colobura dirce, Morpho achiles, Nessaea obrinus, Taygetis celia, T. echo* and *T. virgilia* indicators of more preserved environments.

The use of higher taxa for biodiversity measurements (Williams and Gaston 1994) can be an important management tool for situations where taxonomic identification at the species level is difficult. For the same data set, counting only subfamily abundance, Ramos (1992) obtained similar ordination patterns as when counting species abundance. Another advantage of this fruit-feeding guild is that it can easily be sampled with traps, simultaneously in several points. Using appropriate criteria and guidelines, as suggested by Sparrow et al. (1994), this nymphalid fauna may be an informative species subset for monitoring programs.

The collection of vegetation variables was designed to be as simple as possible. Of course, other local habitat variables that are important for adult butterflies which could have been measured were not quantified. Among the physical and structural variables are the size of the area, topography, temperature, humidity, light, gaps, roosts and dormitories, and ground pattern. Important biological factors for adults include food and ovoposition site availability, predators and mimics.

Local diversity is determined not only by local factors, but also by regional and historical factors (Ricklefs 1987). Aside from the limits of the local habitat structure, the local butterfly assemblage depends on the regional species pool and historical processes such as climatic changes, isolation, extinction and speciation. The rapid fragmentation of the Amazon rain

forest may be contributing to butterfly extinctions, especially larger species with scarce resources - Morphinae, Brassolinae and Charaxinae (Brown 1991). Alternatively, the vegetation structure of disturbed forest is suitable for sun-lovers, secondary and opportunistic species that may spread throughout the region. Some of these butterflies are common in open biomes such as the Cerrado. For example, *Hamadryas februa, H. feronia, Erichthodes numeria* and *Hermeuptychia hermes* are as abundant in cerrado *strictu sensu* of central Brazil (Pinheiro and Ortiz 1992) as in the disturbed areas of the fragment studied.

Literature cited

Beccaloni, G. W. & Gaston, K. J. 1995. Predicting the species richness of neotropical forest butterflies: Ithominae (Lepidoptera: Nymphalidae) as indicators. Biological Conservation 71: 77-86.

Blair, R. B. & Launer, A. E. 1997. Butterfly diversity and human land use: species assemblages along an urban gradient. Biological Conservation 80: 113-125.

Brown Jr, K. S. 1982. Paleoecology and regional patterns of evolution in neotropical forest butterflies. In: Prance, G. T (Ed.) Biological diversification in the tropics. Columbia University Press, New York, USA. Pp 255-308.

———. 1991. Conservation of neotropical environments: insects as indicators. In: Collins, N. M. and Thomas, J. A. (Eds). The conservation of insects and their habitats. Academic Press, New York, USA. Pp 349-404.

Connell, J. H. 1978. Diversity in tropical rain forest and coral reefs. Science 199: 1302-1310.

Courtney, S. P. & Chew, F. S. 1987. Coexistence and host use by a large community of pierid butterflies: habitat is the templet. Oecologia (Berlim) 71: 210-220.

Daily, G. C. & Ehrlich, P. R. 1195. Preservation of biodiversity in small rainforest paches: rapid evaluations using buttefly trapping. Biodiversity and Conservation 4: 35-55.

DeVries, P. J. 1987. The butterflies of Costa Rica and their natural history. Papilionidae, Pieridae, Nymphalidae. Princeton University Press. 327 pp.

———. 1988. Stratification of fruit-feeding nymphalid butterflies in a Costa Rican rainforest. Journal of Research on the Lepidoptera 26 (1-4): 98-108

———. 1994. Patterns of butterfly diversity and promising topics in natural history and ecology. In: L. A. McDade, K. S. Bawa, H. A. Hespenheid and G. S. Hartshorn (Eds). La Selva. Ecology and natural history of a neotropical rain forest. University Chicago Press. pp: 187-194.

DUBOIS, G. S. J. 1993. Diversidade de mariposas (Notodontidae e Arctiidae) num fragmento florestal da amazônia oriental (Açailândia MA). Master Science thesis. Universidade de Brasília, Brasília, Brazil.

EMMEL, T. C. & LECK, C. F. 1969. Seasonal changes in organization of tropical rain forest butterflies populations in Panama. Journal of Research on the Lepidoptera 8 (4): 133-152.

ERHARDT, A. & THOMAS, J. A. 1991. Lepidoptera as indicators of change in the seminatural grasslands of lowland and upland Europe. In: Collins, N. M. and Thomas, J. A. (Eds). The conservation of insects and their habitats. Academic Press, New York, USA. Pp 213-236.

GASTON, K. J. 1996. Species-range-size distribution: patterns, mechanisms and implications. Tree 11 (5): 197-201.

GILBERT, L. E. & SMILEY, J. T. 1978. Determinants of local diversity in phytophagous insects: host specialists in tropical environments. Symposia of the Royal Entomological Society of London 9: 89-104.

HILL, C. J., GILLISON, A. N. & JONES, R. E. 1992. The spatial distribution of rainforest butterflies at three sites in North Queensland, Australia. Journal of Tropical Ecology 8: 37-46.

HILL, J. K., HAMER, K. C, LACE, L. A. & BANHAM, W. M. T. 1995. Effects of selective logging on tropical forest butterflies on Buru, Indonesia. Journal of Applied Ecology 32: 754-760.

HUSTON, M. A. 1994. Biological diversity. The coexistence of species on changing landscapes. Cambridge University Press. Cambridge.

KITAHARA, M. & FUJII, K. 1994. Biodiversity and community structure of temperate butterfly species within a gradient of human disturbance: an analysis based on the concept of generalist vs. specialist strategies. Researches on Population Ecology 36 (2): 187-199.

KREMEN, C. 1992. Assessing the indicator properties of species assemblages for natural areas monitoring. Ecological Applications 2 (2): 203-217.

LEPS, J & SPITZER, K. 1990. Ecological determinants of butterfly communities (Lepidoptera, Papilionoidea) in the Tam Dao Mountains, Vietnam. Acta Entomol. Bohemoslov 87: 182-194.

MACARTHUR, R. H. & MACARTHUR, J. W. 1961. On bird species diversity. Ecology 42 (3): 594-598.

MEFFE, G. K. & CARROLL, C. R. 1997. Principles of conservation biology. Second edition. Sinaver Associates, Inc. Publishers. Sunderland, Massachusetts.

MONTESINOS, J. L. V. 1985. Diversity and species richness of butterflies and skippers in central Spain habitats. Journal of Research on the Lepidoptera 24 (4): 364-371.

MÜLLER-DUMBOIS, D. & ELLEMBERG, H. 1974. Aims and methods of vegetation ecology. John Wiley and Sons, NY, USA. 547 pp.

PIANKA, E. R. 1966. Convexity, desert lizards, and spatial heterogeneity. Ecology 47 (6): 1055-1059.

PINHEIRO, C. E. G. & ORTIZ, J. V. 1992. Communities of fruit-feeding butterflies along a vegetation gradient in central Brazil. Journal of Biogeography 19: 505-511.

RAGUSO, R. A. & LLORENTE-BOUSQUETS, J. 1991. The butterflies (Lepidoptera) of the Tuxtlas Mts., Vera Cruz, Mexico, revisited: species-richness and habitat disturbance. Journal of Research on the Lepidoptera 29 (1-2): 105-133

RAMOS, F. A. 1992. Diversidade de borboletas (Rhopalocera) em uma área da amazônia oriental (Açailândia MA). Master thesis. Universidade de Brasília, Brasília, Brazil.

RICKLEFS, R. E. 1987. Community diversity: relative roles of local and regional processes. Science 235: 167-171.

RUSZCZYK, A. 1986. Distribution and abundance of butterflies in the urbanization zones of Porto Alegre, Brazil. Journal of the Research on the Lepidoptera 25 (3): 157-178.

SHARP, M. A., PARKS, D. R. & EHRLICH, P. R. 1974. Plant resources and butterfly habitat selection. Ecology 55: 870-875.

SINGER, M. C. & EHRLICH, P. R. 1991. Host specialization of Satyrinae butterflies, and their responses to habitat fragmentation in Trinidad. Journal of Research on the Lepidoptera 30 (3-4): 248-256.

SLANSKY JR., F. 1972. Latitudinal gradients in species diversity of the new world swallowtail butterflies. Journal of Research on the Lepidoptera 11 (4): 201-217.

SPARKS, T. H. & PARISH, T. 1995. Factors affecting the abundance of butterflies in field boundaries in Swavesey fens, Cambridgeshire, UK. Biological Conservation 73: 221-227.

SPARROW, H. R., SISK, T. D., EHRLICH, P. R. & MURPHY, D. D. 1994. Techniques and guidelines for monitoring neotropical butterflies. Conservation Biology 8: 800-809.

SPITZER, K., NOVOTNY, V., TONNER, M. & LEPS, J. 1993. Habitat preferences, distribution and seasonality of the butterflies (Lepidoptera, Papilionoidea) in a mountain tropical rain forest, Vietnam. Journal of Biogeography 20: 109-121.

SPITZER, K., JAROS, J, HAVELKA, J & LEPS, J. 1997. Effect of small-scale disturbance on butterfly communities of an indochinese montane rainforest. Biological Conservation 80: 9-15.

TERBRAAK, C. J. F. 1988. CANOCO - a FORTRAN program for canonical community ordination. Microcomputer Power, New York, USA.

THOMAS, C. D. 1991. Habitat use and geographic ranges of butterflies from the wet lowlands of Costa Rica. Biological Conservation 55: 269-281.

VÄISÄNEN, R. 1992. Distribution in abundance of diurnal lepidoptera on a raised bog in southern Finland. Ann. Zoo. Fennice 29: 75-92.

WILLIAMS, P. H. & GASTON, K. J. 1994. Measuring more of biodiversity: can higher-taxon richness predict wholesale species richness? Biological Conservation 67: 211-217.

Appendix 1. Vegetation structure variables and abundance of fruit-feeding butterfly species in twelve sample units of an Amazonian forest fragment. Each species has an abbreviation with the first three letters of the generic and specific names that are used in Figure 1.

		Forest understory			Forest road			Edge	Disturbed forest		Secondary Eucalypts forest monoculture			
		FU1	FU2	FU3	FR1	FR2	FR3	EDG	DFU	DFR	SF4	SF2	EUC	
Vegetation structure variables														
Average tree high (m)		13.8	13.4	18.8	15.7	15.7	13.6	12.4	10.9	10.3	8.1	7.8	16.0	
Average horizontal cover		3.58	3.30	3.36	3.25	3.44	3.77	3.99	3.39	3.61	4.00	3.79	1.33	
Average vertical cover		3.52	3.82	3.93	3.11	3.44	1.96	3.52	3.74	2.74	3.30	2.89	2.82	
Number of tree morfo-species		39	46	49	47	43	38	19	35	33	19	13	1	
Tree density (tree /100m2)		7.85	8.57	7.02	4.44	6.33	5.03	4.13	7.59	7.57	7.24	2.16	15.60	
Average Girth at breast hight		59.1	61.4	73.9	69.4	63.9	61.2	50.8	44.8	38.0	34.0	27.5	34.8	
Butterfly species														Total
MORPHINAE														
Mor ach	*Morpho achiles pindarus* Fruhstorfer, 1912	14	4	13	22	15	9	18	25	26	14	3		163
NYMPHALINAE														
Bib hyp	*Biblis hyperia* (Cramer, 1779)							1	2	14	8	25	9	50
Cal ast	*Callicore astarte* (Cramer, 1799)									2				2
Cal mai	*Callicore maimuna* (Hewitson, 1858)				1			1	1	1				4
Cal pyg	*Callicore pygas thamiras* (Ménétriés, 1857)										5			5
Cal sor	*Callicore sorana* (Godart, 1832)											1	1	2
Cat aco	*Catonephele acontius* (Linnaeus, 1758)				1					1				2
Cat num	*Catonephele numia* (Cramer, 1775)						1							1
Col dir	*Colobura dirce* (Linnaeus, 1758)	19	5	29	11	10	9	22	44	15	13	2	9	188
Dia cly	*Diaethria clymena* (Cramer, 1775)					1	1	2		12	6	2	4	28
Ect the	*Ectima thecla lirina* Felder & Felder, 1867				1									1
Eun tat	*Eunica tatila* (Herrich-Schäfer, 1885)											4		4

The following table lists taxa (code and scientific name) with their recorded counts across sample columns; the final column gives the row total.

Code	Species							Total
Ham amp	*Hamadryas amphinome* (Linnaeus, 1767)		1	1		1		3
Ham chl	*Hamadryas chloe* (Stoll, 1787)	2	6	1	1	2	2	17
Ham feb	*Hamadryas februa* (Hübner, 1823)	2	2	2	2	7	2	13
Ham fer	*Hamadryas feronia* (Linnaeus, 1758)	17	5	23	17	58	48	187
Ham iph	*Hamadryas iphthime* (Bates, 1864)	2	1	7	2	1	5	30
Ham lao	*Hamadryas laodamia* (Cramer, 1777)	2	9		2	4		9
Ham vel	*Hamadryas velutina* (Bates, 1865)			16				31
His ach	*Historis acheronta* (Fabricius, 1775)		1		2	1	1	3
His odi	*Historis odius* (Fabricius, 1775)	1			4	3	1	8
Mys hyp	*Myscelia hypatia* Strecker, 1900	3	30	34	1	1	2	109
Nes obr	*Nessaea obrinus* (Linnaeus, 1758)	4		1	3			43
Nic fla	*Nica flavilla* Hübner, 1826	4	4	14			1	37
Pau per	*Paulogramma peristera* Hewitson, 1853		1	2				3
Pyr nea	*Pyrrhogyra neaerea* (Linnaeus, 1758)	1	1	2	1	2		9
Pyr ota	*Pyrrhogyra otalis* Bates, 1864							1
Tem lao	*Temenis laothoe* (Cramer, 1777)	10	6	24	12	8	3	80
Tig ace	*Tigridia acesta* Hübner, 1819	1	12		1			17
Vil sta	*Vila stalachtoides* Bates, 1864		1	2				3
BRASSOLINAE								
Cal teu	*Caligo teucer* (Linnaeus, 1758)	1		2				5
Cal sel	*Caligopsis seleucida* Hewitson, 1927					1	1	1
Cat ber	*Catoblepia berecynthia* (Cramer, 1777)	1						3
Ery pol	*Eryphanis polixena* (Meerb, 1775)	10	11	5	5	6	4	44
Nar cyl	*Narope cyllabarus* Westwood, 1851	2	3	8	3			16
Ops inv	*Opsiphanes invirae* (Hübner, 1808)	4		2	3			9
CHARAXINAE								
Mem ara	*Memphis arachne arachne* (Cramer, 1777)	1						1
Mem mor	*Memphis morvus morvus* (Fabricius, 1775)	7	3	3	5		2	23
Mem oen	*Memphis oenomais* (Boisduval, 1870)	2	1		2	1		7
Mem phi	*Memphis philumena corita* (Fruhstorfer, 1916)							1

												Total
Mem ryp	*Memphis ryphea* (Geyer, 1834)										1	1
Pre doo	*Prepona demophoon* Hübner, 1806		1									1
Pre don	*Prepona demophon* (Linneaus, 1758)	3	3		3	5	3	3				21
Pre lae	*Prepona laertes* (Hübner, 1811)							2				8
Pre mea	*Prepona meander* (Cramer, 1775)	1			3	1	1					3
Pre omp	*Prepona omphale* (Hübner, 1819)			1		1	1					3
Pre phe	*Prepona pheridamas* (Cramer, 1777)	1										2
Sid mar	*Siderone marthesia* (Cramer, 1777)					1	1					1
Zar ity	*Zaretis itys* (Cramer, 1777)	1	3	2	5	10	10	35	11	2		83
	SATYRINAE											
Bia act	*Bia actorion* (linneaus, 1767)	1	2	1								4
Amp pig	*Amphidecta pignerator* Butler, 1867		1									1
Cae bri	*Caeruleuptychia brixia* (Godart, 1821)	4		1		1	1					8
Cae pen	*Caeruleuptychia pencillata* (Godman, 1905)				2		1					3
Cae sp	*Caeruleuptychia sp*				6	5	9		2	1		23
Cep coa	*Cepheuptychia coelestes* (Butler, 1860)	1	1									2
Cep cep	*Cepheuptychia cephus* (Fabricius, 1775)				2							2
Chl arm	*Chloreuptychia arnaea* (Fabricius, 1777)	1	1		1	1	1					5
Chl chl	*Chloreuptychia chloris* (Cramer, 1782)				1							1
Chl her	*Chloreuptychia herseis* Ebert, 1960	1	1	1	1				1			4
Cis occ	*Cissia occypede* (Fabricius, 1777)	1		1	1			1				5
Cis pen	*Cissia penelope* (Fabricius, 1775)	5	6	2	14	11	17	16	13	116	200	
Cis pal	*Cissia nr. palladia* (Butler, 1866)	1	1	2	2	2	1			2		7
Cis beg	*Cissia "bege"*	1	1	2	1		1					5
Cis ter	*Cissia terrestris* (Butler, 1866)	1	2	3	12	13	8	13	2	4		66
Eri eri	*Erichthodes erichtho* (Butler, 1866)			2	1		3	3				7
Eri num	*Erichthodes numeria* (Felder, 1865)				3		7	7				24
Har bla	*Harjesia blanda* (Möschler, 1876)				1		1	5				2
Har sp	*Harjesia sp*			1				1				1
Her her	*Hermeuptychia hermes* (Fabricius, 1775)	2	3	1	9	9	36	34	96	55		237

Code	Species	1	2	3	4	5	6	7	8	9	10	11	Total
Mag sp	*Magneuptychia sp*			1		1	1		7	6	1		17
Par met	*Pareuptychia metaleuca* (Boisduval, 1870)		3								1		4
Par oci	*Pareuptychia ocirrhoe* (Fabricius, 1789)	2	3	7	12	5	40	7	23	23	2	14	138
Par phr	*Paryphthimoides phronius* (Godart, 1823)	2	2	1	1		24	2	46	115	82	228	503
Pha pha	*Pharneuptychia phares* (Godart, 1821)										1		1
Pha phn	*Pharneuptychia pharnaces* (Weymer, 1911)					5					2	6	13
Pse vel	*Pseudodebis velentina* (Cramer, 1782)			1					1		1		3
Pos pen	*Posttaygetis penelea* (Cramer, 1779)	1											1
Tay cel	*Taygetis celia* (Cramer, 1782)	2		3		1	2	2	1	2	1	3	14
Tay cle	*Taygetis cleopatra* Felder, 1862						2						2
Tay ech	*Taygetis echo* (Cramer, 1779)	2			2	1	5	2			1	1	11
Tay eru	*Taygetis nr. erubescens* Butler, 1868				1	1	1					1	8
Tay ker	*Taygetis kerea* Butler, 1869				1	1	2						3
Tay lac	*Taygetis laches* (Fabricius, 1793)	4	3	9	3	3	33	22	29	22	35	14	180
Tay lar	*Taygetis larua* Felder, 1867	1	1				3	3	1		1	1	11
Tay leu	*Taygetis leuctra* Butler, 1870	1											1
Tay mer	*Taygetis mermeria* (Cramer, 1779)				6								6
Tay vir	*Taygetis virgilia* (Cramer, 1779)											63	63
Yph dis	*Yphthimoides disaffecta* (Butler&Druce, 1874)	5	3	9			11	9	66	50	78		284
Yph sp1	*Yphthimoides sp1*	7		4			12	5	74	25	268	3	381
Yph sp2	*Yphthimoides sp2*	1					3		4	1	2		7